Baltimore Aircoil Company
Controller Operating Instructions

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A. Overview

A1. Installation:

The controller has been factory installed into the BAC Enclosed Controls. Refer to your submittal for descriptions of components included in your package.

A2. Temperature or Pressure Sensor

A two-wire 4-20mA temperature or pressure sensor must be field wired into Enclosed Control terminals TC5 and TC6, per your submittal wiring diagrams for automated control. The temperature sensor must be installed at the following locations:

- Open Cooling Towers: Leaving water piping
- Closed Circuit Cooling Towers: Leaving fluid piping
- Evaporative Condensers: Compressor discharge piping

A flashing red LED on the user interface indicates that the sensor input is either open or out of range.

A3. System Input (Remote):

A system input remote signal must be wired between TC7 and TC8. The controller will operate only when this circuit is closed.

A4. Startup:

Confirm that the facility power lines have been properly wired to the BAC Enclosed Controls per the submittal drawings, and confirm that all field wiring has been completed. Close the Main Circuit Breaker to apply power to the Enclosed Controls.

Once the system input remote contact closes (digital input X0), the controller will operate the unit according to Section E: Sequence of Operation. BAC recommends that the PID Autotune function (see User Interface screens for your unit) be performed when controlling a VFD. This function automatically sets the Gain, Integral, and Differential per system settings. The Autotune function monitors VFD operation for a period of 20 minutes and adjusts accordingly. Additional adjustments may be required as the load varies.

B. System Variables

B1. User Adjustable Variables:

Variable	Description	Default	Range
SP, Open Cooling Towers	**Set Point** • Value at which desired leaving water temperature (LWT) is maintained • LWT must be above upper deadband (UDB) or below lower deadband (LDB) for 10 seconds before any action is taken	75° F	45 -125
SP, Closed Circuit Cooling Towers	**Set Point** • Value at which desired leaving fluid temperature (LFT) is maintained • LFT must be above UDB or below LDB for 10 seconds before any action is taken	75° F	45 - 125
SP, Evaporative Condensers	**Set Point** • Value at which desired discharge pressure (DCP) is maintained • DCP must be above UDB or below LDB for 10 seconds before any action is taken	175 psi	20 - 300
DB	**Deadband Range** • Range in which no action occurs • Deadband range is DB/2 above and below the set point	5	2 - 20
MST	**Minimum Stage Time** • Minimum period of time that the stage operates before cycling • Timer begins when stage cycles on or off	15 min	10 - 60
MOT, pump	**Minimum On Time** • Minimum period of time that the spray pump motor operates before cycling • Timer begins when spray pump cycles on	30 min	10 - 60
ORT	**Stage Override Time** • Minimum period of time that the stage operates before cycling (overridden above HL and below LL)	1 min	1 - 60
ORM	**Stage Override Multiplier** • See high limit (HL) and low limit (LL) descriptions for details	1	1 - 4
Gain	Used for manual tuning of PID only	100	0 - 1000
Integral	Used for manual tuning of PID only	50	0 - 1000
Differential	Used for manual tuning of PID only	2	0 - 100

B2. Internal Variables:

Variable	Description	Value
UDB	**Upper Deadband** • Value at which stages turn on for increased capacity	SP + DB/2
LDB	**Lower Deadband** • Value at which stages turn off for decreased capacity	SP - DB/2
HL	**High Limit** • Value above set point which will cause immediate increase in stages for increased capacity	SP + (ORM x DB)
LL	**Low Limit** • Value below set point which will cause immediate decrease in stages for decreased capacity	SP - (ORM x DB)

C. Stages of Capacity : Open Cooling Towers

Legend:

M[#] .....Main fan motor across-the-line
P[#] .....Pony fan motor across-the-line
High.....High-speed winding
Low.....Low-speed winding
VFD.....Variable Frequency Drive

C1. Units Having 1 Main Fan Motor:

Configuration	ST01	ST02
1-Speed	M1	--
2-Speed	M1 low	M1 high
ENERGY-MISER® Fan System	P1	M1
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	VFD	M1

C2. Units Having 2 Main Motors of Equal Size:

Configuration	ST01	ST02	ST03	ST04
1-Speed	M1	M1 M2	--	--
2-Speed	M1 low	M1 low M2 low	M1 high M2 low	M1 high M2 high
ENERGY-MISER® Fan System	P1	P1 P2	M1 P2	M1 M2
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	VFD 1 VFD 2	M1 VFD 2	M1 M2	--

* Excludes Series V units with 2 motors and 1 casing section

C3. Units Having 2 Main Fan Motors of Different Size (M1 smaller, M2 larger)

Configuration	ST02	ST03	ST04	ST05	ST06
1-Speed	M1	M2	M1 M2	--	--
2-Speed	M1 low	M2 low	M1 low M2 low	M1 high M2 low	M1 high M2 high
ENERGY-MISER® Fan System	P1	P2	P1 P2	M1 P2	M1 M2
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	VFD 1 VFD 2	VFD 1 M1	VFD 1 M2	M1 M2	--

C4. Units Having 3 Main Fan Motors:

Configuration	ST01	ST02	ST03	ST04	ST05	ST06
1-Speed	M1	M1 M2	M1 M2 M3	--	--	--
2-Speed	M1 low	M1 low M2 low	M1 low M2 low M3 low	M1 high M2 low M3 low	M1 high M2 high M3 low	M1 high M2 high M3 high
ENERGY-MISER® Fan System	P1	P1 P2	P1 P2 P3	M1 P2 P3	M1 M2 P3	M1 M2 M3
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	VFD 1 VFD 2 VFD 3	M1 VFD 2 VFD 3	M1 M2 VFD3	M1 M2 M3	--	--

D. Stages of Capacity: Closed Circuit Cooling Towers and Evaporative Condensers

Legend:
S.....All spray pump motors
M[#].....Main fan motor across-the-line
P[#].....Pony fan motor across-the-line
High.....High-speed winding
Low.....Low-speed winding
VFD[#]...Variable Frequency Drive

D1. Units having 1 Main Fan Motor:

Configuration	ST01	ST02	ST03
1-Speed	S	S M1	--
2-Speed	S	S M1 low	S M1 high
VFD	S	S VFD1	--
ENERGY-MISER® Fan System	S	S P1	S M1
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	S	S VFD1	S M1

D2. Units Having 2 Main Fan Motors of Equal Size:

Configuration	ST01	ST02	ST03	ST04	ST05
1-Speed	S	S M1	S M1 M2	--	--
2-Speed	S	S M1 low	S M1 low M2 low	S M1 high M2 low	S M1 high M2 high
VFD	S	S VFD1 VFD2	--	--	--
ENERGY-MISER® Fan System	S	S P1	S P1 P2	S M1 P2	S M1 M2
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	S	S VFD1 VFD2	S M1 VFD2	S M1 M2	--

* Excludes Series V Units with 2 motors and 1 casing section.

D3. Units Having 2 Main Fan Motors of Different Size (M1 smaller, M2 larger):

Configuration	ST01	ST02	ST03	ST04	ST05	ST06
1-Speed	S	S M1	S M2	S M1 M2	--	--
2-Speed	S	S M1 low	S M2 low	S M1 low M2 low	S M1 high M2 low	S M1 high M2 high
VFD	S	S VFD 1 VFD 2	--	--	--	--
ENERGY-MISER® Fan System	S	S P1	S P2	S P1 P2	S M1 P2	S M1 M2
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	S	S VFD 1 VFD 2	S VFD 2 M1	S M1 M2	--	--

D4. Units Having 3 Main Fan Motors of Equal Size:

Configuration	ST01	ST02	ST03	ST04	ST05	ST06	ST07
1-Speed	S	S M1	S M1 M2	S M1 M2 M3	--	--	--
2-Speed	S	S M1 low	S M1 low M2 low	S M1 low M2 low M3 low	S M1 high M2 low M3 low	S M1 high M2 high M3 low	S M1 high M2 high M3 high
VFD	S	S VFD 1 VFD 2	--	--	--	--	--
ENERGY-MISER® Fan System	S	S P1	S P1 P2	S P1 P2 P3	S M1 P2 P3	S M1 M2 P3	S M1 M2 M3
BALTIGUARD™ PLUS Fan System (VFD on pony motor, main motor across the line)	S	S VFD 1 VFD 2 VFD 3	S M1 VFD 2 VFD 3	S M1 M2 VFD 3	S M1 M2 M3	--	--

E. Sequence of Operation: All Units

1. The system input contact (wired between TC7 and TC8) closes, and the controller processes the Leaving Water Temperature (LWT) for Cooling Towers, Leaving Fluid Temperature (LFT) for Closed Circuit Cooling Towers, or Discharge Pressure (DCP) for Evaporative Condensers.

2. When the LWT/ LFT/ DCP rises above the Upper Deadband (UDB), Stage 1 (ST01) will cycle on after 10 seconds.

3. If the LWT/ LFT/ DCP remains between the UDB and High Limit (HL), each additional stage cycles on in ascending order after the Minimum Stage Time (MST) for the previous stage expires.

4. If the LWT/ LFT/ DCP rises above the HL, each additional stage cycles on after the Override Time (ORT) for the previous stage expires.

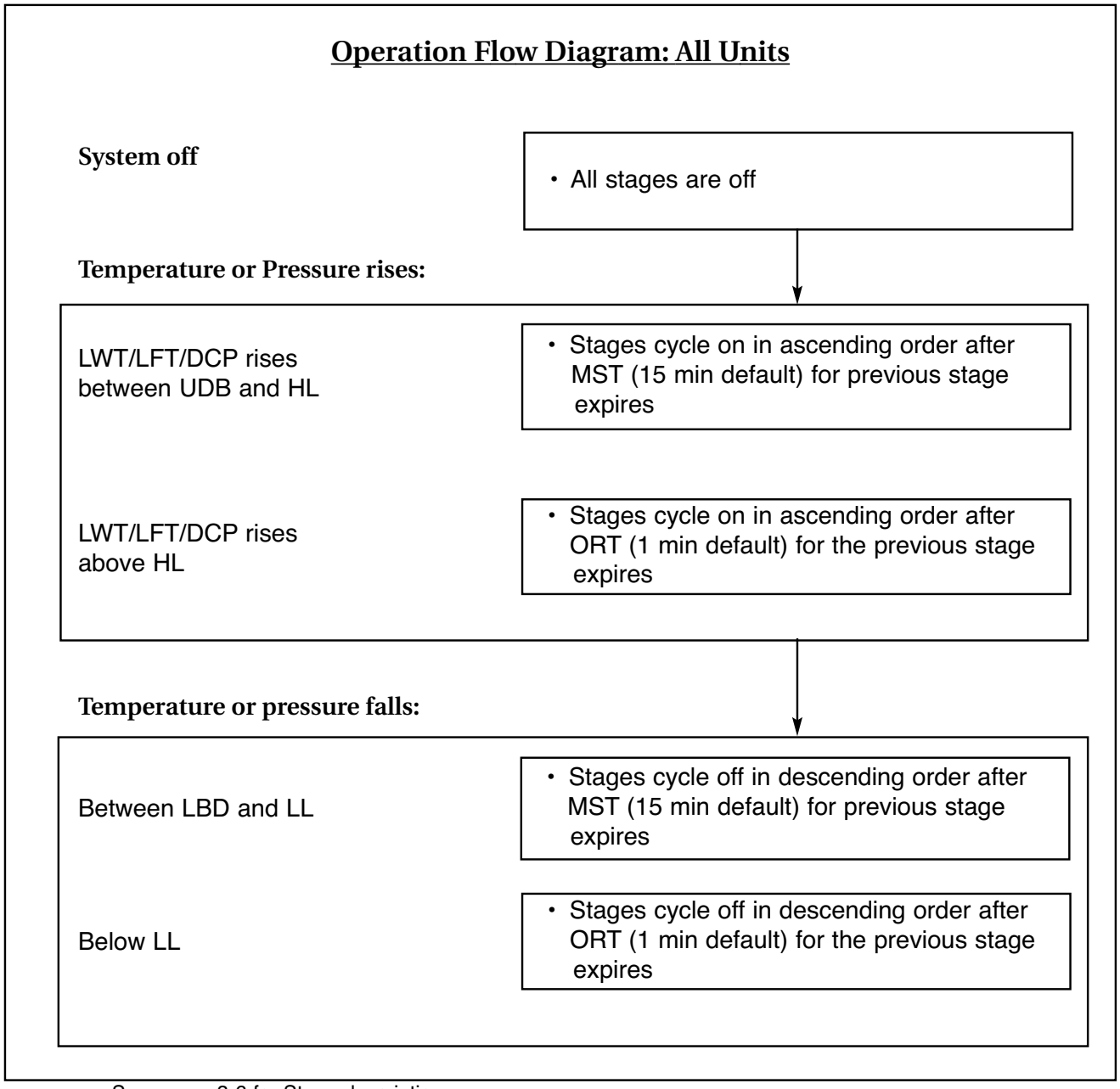
5. When the LWT/ LFT/ DCP is between the Lower Deadband (LDB) and Upper Deadband (UDB), the number of stages currently operating remains unchanged.

6. If the LWT/ LFT/ DCP is between the LDB and lower limit (LL), each additional stage cycles off in descending order only if the MST has expired.

7. If the LWT/ LFT/ DCP falls below the LL, each additional stage cycles off in descending order after the ORT for the previous stage has expired.

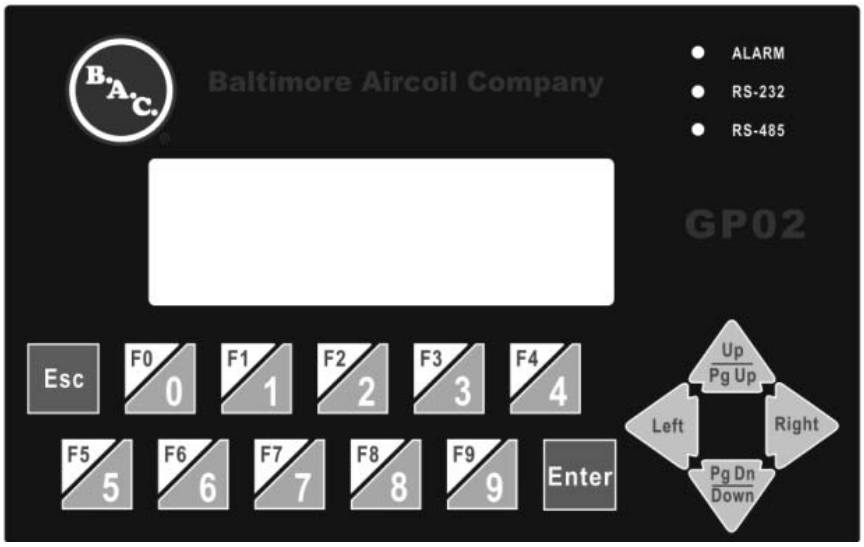
NOTE: The MST and ORT are reset each time a stage is cycled on or off.

Operation Flow Diagram: All Units


System off
• All stages are off
Temperature or Pressure rises:
LWT/LFT/DCP rises between UDB and HL
• Stages cycle on in ascending order after MST (15 min default) for previous stage expires
LWT/LFT/DCP rises above HL
• Stages cycle on in ascending order after ORT (1 min default) for the previous stage expires
Temperature or pressure falls:
Between LBD and LL
• Stages cycle off in descending order after MST (15 min default) for previous stage expires
Below LL
• Stages cycle off in descending order after ORT (1 min default) for the previous stage expires

See pages 3-6 for Stage descriptions

F. Operator Interface Overview:



F1. Changing Screens

- When viewing the main screen, use the Pg Dn/Down button to begin scroll screens. If the screen does not change, press the Pg Dn/Down button multiple times until it changes.
- Press the Up/Pg Up button to return to the previous screen.
- If the backlight is turned off, press any key to turn it on before you can scroll screens.

F2. Changing Set Points

Any numeric value that is displayed in a box is user-adjustable.

1. Press the respective function key in order to change default values.
   a. For default values and parameter function keys, see section F3: Operator Menu Screens.
2. After pressing the appropriate function key, use the Left and Right arrow keys to align the cursor to the position of the value you want to change.
3. Enter the number, and then move to the next position with the arrow keys if required.
4. Press the Enter key to accept the selected value.
5. You can press the Esc key at any time to cancel the set point change. If you attempt to enter a value that is out of range, the message “OUT OF RANGE” will briefly appear on the screen.

G. Operator Menu Screens:

The order in which the following screens appear may vary depending on your Evaporative Cooling Equipment.

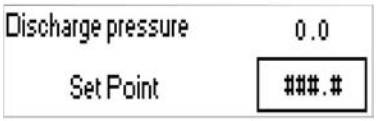
Screen A: Water Temperature Monitoring (Cooling Towers only)

- **Leaving Water Temperature** is the current value in ˚F of the leaving fluid from the cooling tower.
- **Set Point** is the temperature the controller will attempt to maintain by cycling the cooling tower motor(s).
- To change the set point, press the F0 key.

Screen B: Fluid Temperature Monitoring (Closed Circuit Cooling Towers only)

- **Leaving fluid temperature** is the current value in ˚F of the leaving fluid from the unit.
- **Set Point** is the temperature the controller will attempt to maintain by cycling the cooling tower motor(s).
- To change the set point, press the F0 key.

Screen C: Discharge Pressure Monitoring (Evaporative Condensers only)

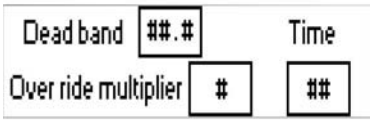


- **Discharge Pressure** is the current value in PSIG of the compressor discharge.
- **Set Point** is the pressure the controller will attempt to maintain by cycling the cooling tower fan.
- To change the set point, press the F0 key.

Screen D: Controller Status

- **RemoteSignal** is the run enable signal required by the controller to turn the motor on (field-wired between TC7 and TC8). Once the system input contact closes, the controller will cycle the cooling tower motor(s) to maintain the set point.
- **Sensor Status** indicates when the remote sensor signal is being received by the controller. If the sensor signal fails open, the Alarm light on the operator interface will flash and the controller will shut down the motor(s).

Screen E: Control Data

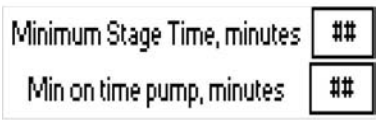


- **Deadband** is the range above and below the set point within which no action is taken (see LDB and UDB calculations on page 3). For example, a deadband of 5 signals the controller to cycle on the next stage at 2.5 above the set point and to cycle off the highest stage 2.5 below the set point.
- **Override Multiplier** (ORM) is used to establish the high and low limit overrides (HL and LL, respectively).
- **Time** is the time in minutes that the LWT/LFT/DCP must be greater than the high limit (HL) or less than the low limit (LL) to override the Minimum Stage Time (MST).

Screen F: Fan Control (Cooling Towers only)

- **Minimum Stage Time** (MST) is the minimum period, in minutes, for which each stage operates after cycling on or off.
- To change the value, press the F0 key.

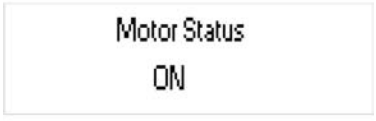
Screen G: Fan and Pump Control (Closed Circuit Cooling Towers and Evaporative Condensers only)



- **Minimum Stage Time** (MST) is the minimum period, in minutes, for which each stage operates after cycling on or off.
- To change the value, press the F0 key.

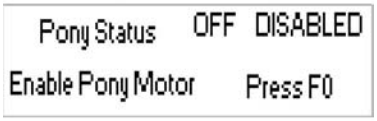
- **Minimum on time pump (MOT)** is the minimum period, in minutes, for which the spray pump motor runs once it cycles on.
- The spray pump will never cycle more frequently than the MST allows.
- To change the value, press the F1 key.

Screen H: Motor Status



- **Motor status** indicates whether the fan motor is stopped or running

Screen I: Pony Status (ENERGY-MISER® Fan System with VFD on main motor, only)



- **Pony Status** indicates whether the pony motor is stopped or running.
- Press F0 to enable or disable the pony motor
- When enabling and disabling the pony motor, the main motor will be enabled and disabled, respectively.
- Pony motor should be enabled when the user would like to operate the pony motor and disable the VFD on the main motor

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Screen J: Pump Status (Closed Circuit Cooling Towers and Evaporative Condensers only)

- **Spray Pump Status** indicates whether the motor is stopped or running.
- In **Wet Mode**, the spray pump is used as the first stage for heat rejection. In **Dry Mode**, the spray pump is not used, and only the fan motors are running.

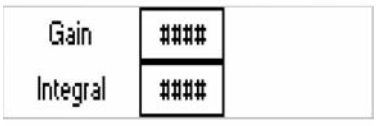
Screen K: Program Information

- **Program number** is the current operating logic of the controller.
- **ELC Rev** is the current operating revision of the controller.
- **OI Rev** is the current operating revision of the operator interface panel.

Screen L: PID Status (VFD only)

- **PID Output** is the value that the controller sends to the analog output, 4-20mA.

Screen M: PID Control (VFD only)

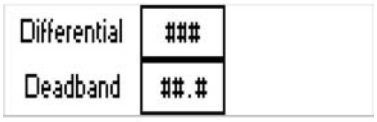


- **The Gain** is the amount by which the controller will increase the output when the leaving water temperature is above the UDB.
- To change this value, press the F0 key.

- The allowable range is 0 – 1000 (recommended starting value = 100).

- **Integral** is the frequency by which the controller increases the output when the leaving water temperature is above the UDB.
- To change this value, press the F1 key.
- The allowable range is 0 – 1000 (recommended starting value = 50).

Screen N: PID Setpoints



- The **Differential** is the rate at which the controller changes the output based on how quickly the leaving water temperature rises above or falls below the set point.
- The Differential remains active in changing the output until the leaving water temperature falls below the LDB.
- To change this value, press the F0 key.

- The **Deadband** is the range in which no action is taken by the controller.
- The range is split above and below the set point.
- The controller will not begin to increase the output until the leaving water temperature is above the UBD and will continue applying output until the leaving water temperature is below the LDB.
- To change this value, press the F1 key.

Screen O: PID Autotune (VFD only)

- The controller has a **PID Autotune** feature.
- By pressing the F1 key from this screen, the controller will enter a 20 minute adjustment cycle of the output in response to set point deviation.
- This process will automatically determine values for the Gain, Integral, and Differential.
- The circle on the screen will be shaded and the text “Autotune Active” will flash.
- Autotune can be stopped at any point by pressing the F2 key. Any values written to the Gain, Integral, and Differential will be retained.

Screen P: I/O Status

- An open circle indicates an open input or output (turned off), while a dark circle indicates a closed input or output (turned on).
- Digital inputs: X0, X1
- Digital outputs: Y0, Y1 on base module, Y0 through Y7 on the first expansion module, Y0 and Y1 on the second expansion module.

Screen Q: I/O Status (cont'd)

- Outputs Y20 through Y25 on the screen correspond to outputs Y0 through Y5 on the first expansion module
- The circle next to the corresponding digital I/O will be dark when the controller is reading that the I/O is active.
- If the controller is not reading an input as active and you have confirmed the appropriate voltage with a multimeter, then the input is no longer functioning properly.
- All digital outputs are Normally Open relay contacts. If the controller is showing the output to be active and you do not measure the appropriate voltage level with a multimeter, then the output is not functioning properly.

Screen R: I/O Status (cont'd)

- Outputs Y26 and Y27 on the screen correspond to outputs Y6 and Y7 on the first expansion module.
- Outputs Y30 and Y31 on the screen correspond to outputs Y0 and Y1 on the second expansion module.